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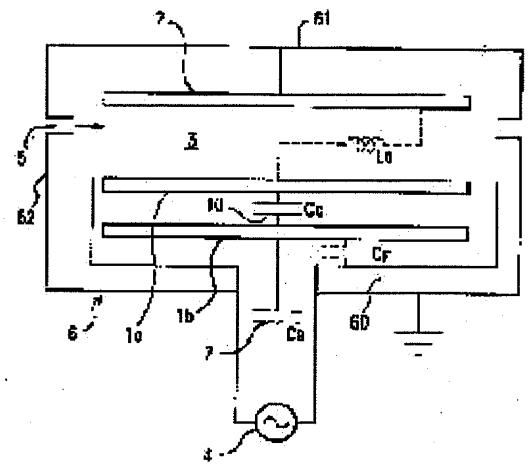
(54) ELECTRIC DEVICE MANUFACTURING DEVICE AND METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide the high-frequency plasam CVD(chemical vapor deposition), device making feasible large area film formation or large area etching step, when the excited high-frequency extends from RF radiofrequency wave band a VHF(very high frequency) band.
SOLUTION: An anode electrode 2 in the potential at ground level, an upper side cathode electrode 1a and a lower side cathode electrode 1b are arranged inside a reaction chamber 6. Further, a high-frequency power generating source 4 is arranged beneath the bottom wall 60. Next, a DC-shielding capacitor element 7 (CB) made of a capacitor DC-connected between the power source 4 and the lower cathode electrode 1b. Furthermore, an impedance-adjusting capacitor (CC) made of another capacitor is DC-connected between the upper cathode electrode 1a and the lower cathode electrode 1b.



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[JP,10-032171,A]
[Claim(s)]
[Claim 1] A reactant gas installation means to introduce reactant gas, such as etching gas for processing material gas, dilution gas or a semiconductor device for making a thin film semiconductor etc. deposit, etc., into a reaction chamber, A high-frequency power generating means to generate the high-frequency power for understanding this reactant gas by the plasma, Are the electron device manufacturing installation equipped with the cathode electrode for high-frequency excitation by which the series connection was carried out to this high-frequency power generating means, and it sets between this cathode electrode and this high-frequency power generating means. The electron device manufacturing installation which inserted the capacity for impedance adjustment with the capacity component below the stray capacity which this cathode electrode and this cathode electrode, and the part that is in same electric potential in direct current have to the part in the interior wall or touch-down potential of this reaction chamber so that it might become this stray capacity and a series connection.
[Claim 2] The electron device manufacturing installation according to claim 1 which was equipped with the capacitative element for direct-current cutoff by which series connection was carried out between said high-frequency power generating means and said cathode electrodes, and inserted said capacity for impedance adjustment between this cathode electrode and this capacitative element for direct-current cutoff.
[Claim 3] The electron device manufacturing installation according to claim 1 or 2 inserted in the part which can consider in this frequency that said capacity for impedance adjustment is a serial equivalent to said stray capacity which exists equivalent in the frequency of the excitation RF of said cathode electrode.
[Claim 4] The electron device manufacturing installation according to claim 1 or 3 said whose capacity for impedance adjustment is the means which insulated said cathode electrode from said high-frequency power generating means in direct current.
[Claim 5] The electron device manufacturing installation according to claim 2 or 3 said whose capacity for impedance adjustment is the means insulated from said capacitative element for direct-current cutoff in direct current.
[Claim 6] The electron device manufacturing installation according to claim 1 in which said capacity for impedance adjustment is formed with the dielectric prepared on said cathode electrode.
[Claim 7] It is C<=1/so that magnitude C of a whole capacity when carrying out series connection of said capacity for impedance adjustment and said stray capacity may fulfill the conditions of following the (1) type {LG (2 pi-f) and 2}. -- (1)

However, the magnitude pi:circular constant f of the induction component which exists equivalent between the parts in the touch-down potential which counters the electrode surface of LG:cathode electrode and this cathode electrode: The electron device manufacturing installation according to claim 1 to 6 in which excitation high frequency carried out a frequency setup.

[Claim 8] A reactant gas installation means to introduce reactant gas, such as etching gas for processing material gas, dilution gas or a semiconductor device for making a thin film semiconductor etc. deposit, etc., into a reaction chamber, A high-frequency power generating means to generate the high-frequency power for understanding this reactant gas by the plasma, It is the electron device manufacturing installation equipped with the cathode electrode for high-frequency excitation by which the series connection was carried out to this high-frequency power generating means. The inductance for impedance adjustment is inserted in the location which becomes the stray capacity CF which this cathode electrode and this cathode electrode, and the part that is in same electric potential in direct current have to the part in the interior wall or touch-down potential of this reaction chamber, and parallel connection. It is LC>=1/so that the capacity component LC of this inductance for impedance adjustment may fulfill the conditions of following the (2) type {(2 and pi-f) 2 and CF}. -- (2)

The set-up electron device manufacturing installation.

[Claim 9] A reactant gas installation means to introduce reactant gas, such as etching gas for processing material gas, dilution gas or a semiconductor device for making a thin film semiconductor etc. deposit, etc., into a reaction chamber, A high-frequency power generating means to generate the high-frequency power for understanding this reactant gas by the plasma, It is the electron device manufacturing installation equipped with the cathode electrode for high-frequency excitation by which the series connection was carried out to this high-frequency power generating means. The inductance for impedance adjustment is inserted in the location which becomes the stray capacity CF which this cathode electrode and this cathode electrode, and the part that is in same electric potential in direct current have to the part in the interior wall or touch-down potential of this reaction chamber, and parallel connection. It is LC<1/so that the capacity component LC of this inductance for impedance adjustment may fulfill the conditions of following the (3) type {(2 and pi-f) 2 and CF}. -- (3)

The set-up electron device manufacturing installation.

[Claim 10] The electron device manufacturing installation according to claim 8 or 9 inserted in the part which can consider in this frequency that said inductance for impedance adjustment is juxtaposition equivalent to said stray capacity CF which

exists equivalent in the frequency of the excitation RF of said cathode electrode.

[Claim 11] The electron device manufacturing installation according to claim 8 to 10 said whose inductance for impedance adjustment is a means to come to connect said cathode electrode with the part in said touch-down potential too hastily in direct current.

[Claim 12] The electron device manufacturing installation according to claim 8 to 11 from which the outside of said cathode electrode is equipped with an electrode side dielectric, and this cathode electrode and this electrode side dielectric constitute the bottom wall of said reaction chamber.

[Claim 13] The electron device manufacturing installation according to claim 8 to 11 from which said cathode electrode has an anode electrode for the shape of a cylinder in nothing and its inside, and the outside of this cathode electrode is equipped with an electrode side dielectric, and this cathode electrode and this electrode side dielectric constitute the wall of said reaction chamber.

[Claim 14] The electron device manufacturing installation [equipped with a capacity for impedance adjustment according to claim 1 to 7] according to claim 8 to 13.

[Claim 15] D>=(1/16) -lambda with which the magnitude of said cathode electrode fills the conditions of following the (4) type -- (4)

However, the maximum dimension lambda securable for D:cathode electrode surface: The electron device manufacturing installation according to claim 1 to 14 set as the wavelength magnitude of the high frequency excited from a cathode electrode.

[Claim 16] D>=(1/8) -lambda with which the magnitude of said cathode electrode fills the conditions of following the (5) type -- (5)

However, the maximum dimension lambda securable for D:cathode electrode surface: The electron device manufacturing installation according to claim 1 to 14 set as the wavelength magnitude of the high frequency excited from a cathode electrode.

[Claim 17] D0<=(1/2) -lambda with which the magnitude of said reaction chamber fills the conditions of following the (6) type -- (6)

However, the electrode surface inside a D0:reaction chamber and the maximum dimension lambda securable in parallel: Claim 1 set as the wavelength magnitude of the RF excited from a cathode electrode - claim 8, or an electron device manufacturing installation according to claim 10 to 15.

[Claim 18] D0>=(1/2) -lambda with which the magnitude of said reaction chamber fills the conditions of following the (7) type -- (7)

However, the electrode surface inside a D0:reaction chamber and the maximum dimension lambda securable in parallel: The electron device manufacturing installation according to claim 9 to 15 set as the wavelength magnitude of the high frequency

excited from a cathode electrode.

[Claim 19] The electron device manufacturing installation according to claim 1 to 18 by which the excitation frequency set the RF conditions of said high-frequency power generating means as the continuous discharge of a RF VHF band.

[Claim 20] The electron device manufacturing installation according to claim 1 to 18 by which the excitation frequency set the RF conditions of said high-frequency power generating means as the pulse discharge of a RF VHF band.

[Claim 21] The manufacture approach of an electron device of manufacturing an electron device by using an electron device manufacturing installation according to claim 1 to 20, plasma-exciting, decomposing material gas, and depositing a thin film from a gaseous phase on a substrate.

[Claim 22] The manufacture approach of an electron device of manufacturing an electron device using plasma particles and the active species by plasma excitation etching the film using an electron device manufacturing installation according to claim 1 to 20.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to an electron device manufacturing installation suitable as a plasma etching system used in order to process in more detail the plasma excitation chemical-vapor-deposition equipment (it is described as plasma-CVD equipment below) or the semiconductor device used for the manufacture of semi-conductor thin films, such as a hydrogenation amorphous silicon (it is described as a-Si:H below), or an insulator layer in electronic industry, a liquid crystal device, etc. about an electron device manufacturing installation, and the electron device manufacture approach using this electron device manufacturing installation.

[0002]

[Description of the Prior Art] The plasma dry etching system used in order to process a semiconductor device, a liquid crystal display component, etc. using the plasma-CVD equipment which plasma-excites, decomposes material gas and deposits a thin film from a gaseous phase, or the active species according to plasma particles and plasma excitation conversely etching the film is widely used as a manufacturing installation of an electron device today for a metal membrane / semi-conductor film / dielectric film, or the crystal wafer.

[0003] these electron device manufacturing installations -- setting -- the present -- the many -- a radio wave (called 13.56MHz, RF, or RF HF) -- or it is put in practical use by making microwave (2.45GHz, MW wave) into the excitation frequency of the power

source which generates the plasma.

[0004] It is shown clearly that the two above-mentioned person's middle frequency domain (for example, called about 100MHz and a high high frequency VHF band) has the features which were experimentally [theoretically or] suitable for manufacture of an electron device as an excitation frequency of the RF generator used from the energetic research in the latest plasma science on the other hand in order to generate the plasma. The following are mentioned as an example of such reference.

[0005] (1)J.Vac.Sci.Technol.A10(1992)1080A.A.Howling et al.

(2)Plasma Sources Sci.Technol.2(1993)p.40-45 T.Kitamura et al.

(3) Plasma Sources Sci.Technol.2(1993) p.26-29 The point that a plasma consistency increases or is realized in proportion to the square of a frequency by plasma potential with such a comparatively low high plasma consistency as features suitable for manufacture of the S.Oda(4) JP,6-77144,A above-mentioned electron device is mentioned.

[0006] It means that mean that the rate of film deposition increases the former features in proportion to the square of a frequency, and an etch rate will increase in proportion to the square of a frequency if it is an etching system. Moreover, the latter features make it possible to stop low the damage to the film or substrate by the ion kind in the plasma, and the so-called plasma damage, though it is under such high-speed membrane formation and a high-speed etching condition.

[0007]

[Problem(s) to be Solved by the Invention] By the way, in an electronic industrial field which is called the so-called giant microelectronics, such as a solar battery using an a-Si:H system thin film, and a liquid crystal display component or a sensitization layer of a photo conductor drum, the dimensions of the substrate itself are 40cm - 60cm and a long picture, and the reaction chamber which can process two or more substrates like a parenthesis at once is becoming indispensable for high-throughput-izing of equipment. Moreover, in order for semiconductor fabrication machines and equipment to also realize a high throughput, it is very important to process many substrates at once. Enlarging size of a reaction chamber for such a reason, it is important an equipment dimension, i.e., reaction space, and to more specifically enlarge the electrode surface dimension of a cathode electrode and an anode electrode.

[0008] however, in what was indicated by the above-mentioned reference, reaction space is markedly boiled compared with the wavelength of the RF for plasma excitation currently used, and is small. That is, for example, reaction space is less than [about 10cm and it] to wavelength being set to about 3m on the frequency of 100MHz. For this

reason, the present condition is enlarging reaction space and having come to realize a suitable electron device manufacturing installation in an electronic industrial field which is called giant microelectronics.

[0009] it is considered to be based on the following reasons that according to this invention person's etc. view reaction space must be markedly boiled compared with the wavelength of the excitation power line period of a VHF band, and must be made small here. That is, if reaction space becomes comparable as the wavelength of the excitation power line period of a VHF band, the electromagnetic wave generated by this begins to have a special feature as a wave which spreads reaction space, and in order that the electromagnetic-like change of the reactor resulting from this may cause generation of the structurally complicated plasma, it will think because the control of the plasma itself becomes impossible.

[0010] About the above phenomena, the consideration based on the experimental result using the plasma-CVD equipment of the conventional type shown in drawing 17 is shown below. In addition, the electrode dimension of the plasma-CVD equipment for a sample offering is 700mm angle.

[0011] In this plasma-CVD equipment, when the frequency of 13.56MHz or a 20MHz RF generates the plasma, it discharges only in the normal position of the inter-electrode space 3 shown in drawing 18 (space between the cathode electrode 1 - the anode electrode 2), i.e., reaction space. On the other hand, when the frequency was set to 27.12MHz or 35MHz, it has checked that discharge occurred also in an abnormality part (it is a part if it does not contribute to film growth at all) not only like inter-electrode space but the electrode side space 101,101 which is the space of the method of both sides, i.e., the space between the both ends of electrodes 1 and 2, and the side wall of a reaction chamber, and the background space 102 of the anode electrode 2.

[0012] Moreover, when the frequency was raised to 40.68MHz or more, in the inter-electrode space 3, it has checked not discharging but discharging only in an abnormality part like the electrode side space 101,101 and the background space 102. The abnormality situation where membrane formation did not take place even if it installs the substrate (wafer) which is the body formed membranes like usual in the front face of the anode electrode 2 which touches the reaction space 3 at this time had occurred.

[0013] Furthermore, this invention person etc. investigated this abnormality discharge phenomenon about the case where the magnitude of the plasma-CVD equipment of a conventional type changes. As shown in drawing 19 , with the small equipment of 200mm angle, discharge of only electrode space normal to the frequency of 81.36MHz is

obtained for the dimension of the cathode electrode 1 among equipment with the cathode electrode 1 of a square mold, but it turns out that the frequency limitation that normal inter-electrode space discharge is realized becomes low as the dimension of the cathode electrode 1 becomes large.

[0014] And if the dimension of the cathode electrode 1 serves as 1200mm angle, normal inter-electrode discharge is not obtained on the frequency of 13.56MHz, on the frequency of 40.68MHz or more, it will become only abnormality part discharge and membrane formation will not take place on the substrate installed in the front face of the anode electrode 2.

[0015] Thus, with the plasma-CVD equipment of a conventional type, it has checked that it originated in the above-mentioned abnormality part discharge, and the large area discharge and the large area film using the RF of a VHF band could not be realized.

[0016] Here, when the frequency of an excitation RF and the magnitude of plasma-CVD equipment are considered for the situation of such abnormality part discharge as a parameter, as shown in drawing 19 , it is D>=(1/16) -lambda. -- (4)

However, die-length [of one side] lambda of D:square mold cathode electrode: It turned out that abnormality part discharge occurs in the field of the wavelength (= the velocity of light/frequency) of the RF excited from this cathode electrode in addition to normal inter-electrode discharge.

[0017] Moreover, D>=(1/8) -lambda -- (5)

In ******, it turned out that normal inter-electrode discharge does not take place, but only abnormality part discharge occurs.

[0018] By the way, the approach of inserting the capacitative element for direct-current cutoff and the approach of adding the component for impedance adjustment to the perimeter of an electrode are learned as technique for trying control of the plasma generated by the RF of RF band.

[0019] The former approach is:"Glow. Discharge Processes"John Wiley & It is indicated by Sons(1980) B.Chapmann and the latter approach is indicated by JP,58-145100,A and JP,6-61185,A.

[0020] In addition, as a location which inserts the component for impedance adjustment, the capacitative element for direct-current cutoff was outside the reactor which is usually separated from a cathode electrode, and was between the internal parts of a cathode electrode by the approach indicated by JP,58-145100,A, and was by the approach indicated by JP,6-61185,A between a cathode electrode, the electrode which counters, and touch-down potential.

[0021] However, such technique remains for the ability applying to what aimed at

control of the plasma production on condition of use of the RF of RF band, and even if it applies to the electron device manufacturing installation using the RF of a VHF band, it cannot solve the above-mentioned technical problem. The reason is explained below.

[0022] Now, in the so-called capacity-coupling type of electron device manufacturing installation of an parallel monotonous mold, reaction space or an electrode dimension explains [a cathode electrode and an anode electrode] taking the case of the large-sized equipment around 1m. With capacity-coupling mold equipment, as shown in drawing 17 , the plasma is generated to the space 3 (inside of a gaseous phase) between the cathode electrode (high-frequency excitation electrode) 1 and the anode electrode 2 which counters this and is in touch-down potential in direct current, ingredient gas is dissociated to it, and deposition or etching of a thin film is performed to it.

[0023] When the frequency of an excitation RF is in RF band, it can be considered that the impedance between two electrodes 1 and 2 is a capacity component. In this case, the plasma is generated in the space between an electrode 1 and 2, and the usual membrane formation is possible.

[0024] However, an excitation RF will come to be tinctured with the property of the electromagnetic wave to spread if a frequency becomes a VHF band. therefore, the conductor which encloses reaction space -- in a certain frequency, a parallel resonance phenomenon will arise between the stray capacity which a group comes to have an induction component equivalent and the cathode electrode 1 has. In this case, since it becomes the impedance of the space between two electrodes 1 and 2 being very large, and being the same as that of the space which spreads to infinity equivalent, the plasma production between an electrode 1 and 2 becomes difficult.

[0025] Although it will be necessary to control the impedance of the cathode electrode 1 to a touch-down potential part in order to cope with this problem, it is difficult to correspond by the approach of inserting the capacitative element for direct-current cutoff which is the conventional control approach, or the approach given in JP,58-145100,A or JP,6-61185,A.

[0026] That is, as shown in drawing 17 , since it is inserted in RF generator (high-frequency power generation source) 4 and the serial, in view of the cathode electrode 1, the capacitative element 7 for direct-current cutoff which consists of a capacitor cannot perform control of the stray capacity value which poses a problem now. Moreover, by the approach given in JP,58-145100,A, the impedance of a cathode electrode and an external circuit does not change in essence. Moreover, since the component for impedance adjustment is attached in an anode electrode side, the impedance of a cathode electrode is uncontrollable by the approach given in

JP,6-61185,A.

[0027] In the plasma-CVD equipment shown in drawing 17 when it explains now somewhat concretely, considering propagation of the RF of a VHF band, stray capacity CF [C/V=F] is mainly produced under the cathode electrode 1, and the reaction space 3 between the cathode electrode 1 - the anode electrode 2 (inter-electrode space) serves as an inductance LG [Wb/A=H] equivalent.

[0028] Here, it is given by following the (8) formula, and stray capacity CF is CF=epsilon-S 1/d0. -- (8)

d0: In short circuit waveguide approximation, the distance inductance LG between opposed faces of a cathode electrode and an anode electrode is given by following the (9) formula.

[0029]

LG=Axtan{(2pi-f-S2/c)} /(2 pi-f) -- (9)

However, epsilon: Dielectric constant [C/V-m]

S1: Opposed face area of a cathode electrode and an anode electrode [m2]

d: Distance between opposed faces of a cathode electrode and an anode electrode [m]

f: Frequency [1/S]

S2: Electrode surface lay length of inter-electrode space [m]

c: Velocity of light [m/S]

Moreover, Above A is a constant expressed with following the (10) type.

[0030]

A=(d/W) -root(micro/epsilon)} -- (10)

However, W: Electrode width of face [m]

mu: Permeability [Wb/A]

Here, since stray capacity CF and an inductance LG are in a parallel connection condition between the cathode electrode 1 and a touch-down part, when a frequency f turns into the resonance frequency f0 of following the (11) type, it will be in a parallel resonance condition, and the impedance of an electrode 1 and the reaction space 3 between two will serve as infinity, so that drawing 17 may show.

[0031]

f0=1/(2pi-root (LGCF)) -- (11)

That is, the frequency f of the excitation RF to be used is the same as this parallel resonating frequency f0, or, in the case of a near value, the plasma production between an electrode 1 and 2 cannot be expected.

[0032] Then, although it will be necessary to control the impedance of the reaction space 3, since the magnitude of the reaction space 3 is decided by magnitude of a membrane

formation substrate, it is difficult [it] to change the magnitude of an inductance LG in practice.

[0033] When enlarging an equipment dimension, i.e., reaction space, for the above reason in the electron device manufacturing installation using the high frequency of the conventional VHF band, there was constraint. For this reason, the mass-production nature of an electron device was not able to be improved.

[0034] this invention be make in view of such the present condition , also when use the RF of a VHF band as a RF for plasma excitation power sources , reaction space can be enlarge , and it aim at offer the electron device manufacturing installation which boil the mass production nature of these electron devices markedly , and can improve in an electronic industrial field which be call the so-called giant microelectronics , such as a solar battery using an a-Si:H system thin film , and a liquid crystal display component or a photo conductor drum , as a result .

[0035] Other purposes of this invention are to offer the electron device manufacturing installation that whose the damage to the film or substrate by the ion kind in the plasma and the so-called plasma damage are stopped low it can improve the quality of an electron device by becoming possible, though it is under high-speed membrane formation and a high-speed etching condition.

[0036]

[Means for Solving the Problem] A reactant gas installation means to introduce reactant gas, such as etching gas for processing material gas, dilution gas or a semiconductor device for the electron device manufacturing installation of this invention making a thin film semiconductor etc. deposit, etc., into a reaction chamber, A high-frequency power generating means to generate the high-frequency power for understanding this reactant gas by the plasma, Are the electron device manufacturing installation equipped with the cathode electrode for high-frequency excitation by which the series connection was carried out to this high-frequency power generating means, and it sets between this cathode electrode and this high-frequency power generating means. The capacity for impedance adjustment with the capacity component below the stray capacity which this cathode electrode and this cathode electrode, and the part that is in same electric potential in direct current have to the part in the interior wall or touch-down potential of this reaction chamber It inserts and becomes so that it may become this stray capacity and series connection, and the above-mentioned purpose is attained by that.

[0037] It has preferably the capacitative element for direct-current cutoff by which series connection was carried out between said high-frequency power generating means and said cathode electrodes, and considers as the configuration which inserts said

capacity for impedance adjustment between this cathode electrode and this capacitative element for direct-current cutoff.

[0038] moreover, it considers as the configuration inserted in the part which can consider preferably that said capacity for impedance adjustment is a serial equivalent in this frequency to said stray capacity which exists equivalent in the frequency of the excitation RF of said cathode electrode.

[0039] Moreover, it considers as the configuration using a means to insulate said cathode electrode from said high-frequency power generating means in direct current, as said capacity for impedance adjustment preferably.

[0040] Moreover, it considers as the configuration using a means to insulate from said capacitative element for direct-current cutoff in direct current as said capacity for impedance adjustment preferably.

[0041] Moreover, it considers as the configuration which forms said capacity for impedance adjustment preferably with the dielectric prepared on said cathode electrode.

[0042] Moreover, it is C<=1/so that magnitude C of a whole capacity when carrying out series connection of said capacity for impedance adjustment and said stray capacity may fulfill the conditions of following the (1) type preferably {LG (2 pi-f) and 2}. -- (1) however, the frequency setting of the magnitude pi:circular constant f:excitation RF of the induction component which exists equivalent between the parts in the touch-down potential which counters the electrode surface of LG:cathode electrode and this cathode electrode -- it carries out.

[0043] Moreover, a reactant gas installation means to introduce reactant gas, such as etching gas for processing material gas, dilution gas or a semiconductor device for the electron device manufacturing installation of this invention making a thin film semiconductor etc. deposit, etc., into a reaction chamber, A high-frequency power generating means to generate the high-frequency power for understanding this reactant gas by the plasma, It is the electron device manufacturing installation equipped with the cathode electrode for high-frequency excitation by which the series connection was carried out to this high-frequency power generating means. The inductance for impedance adjustment is inserted in the location which becomes the stray capacity CF which this cathode electrode and this cathode electrode, and the part that is in same electric potential in direct current have to the part in the interior wall or touch-down potential of this reaction chamber, and parallel connection. It is LC>=1/so that the capacity component LC of this inductance for impedance adjustment may fulfill the conditions of following the (2) type {(2 and pi-f) 2 and CF}. -- (2)

It comes to set up and the above-mentioned purpose is attained by that.

[0044] Moreover, a reactant gas installation means to introduce reactant gas, such as etching gas for processing material gas, dilution gas or a semiconductor device for the electron device manufacturing installation of this invention making a thin film semiconductor etc. deposit, etc., into a reaction chamber, A high-frequency power generating means to generate the high-frequency power for understanding this reactant gas by the plasma, It is the electron device manufacturing installation equipped with the cathode electrode for high-frequency excitation by which the series connection was carried out to this high-frequency power generating means. The inductance for impedance adjustment is inserted in the location which becomes the stray capacity CF which this cathode electrode and this cathode electrode, and the part that is in same electric potential in direct current have to the part in the interior wall or touch-down potential of this reaction chamber, and parallel connection. It is LC<1/so that the capacity component LC of this inductance for impedance adjustment may fulfill the conditions of following the (3) type {(2 and pi-f) 2 and CF}. -- (3)

It comes to set up and the above-mentioned purpose is attained by that.

[0045] it considers as the configuration inserted in the part which can consider preferably that said inductance for impedance adjustment is juxtaposition equivalent in this frequency to said stray capacity CF which exists equivalent in the frequency of the excitation RF of said cathode electrode.

[0046] Moreover, it considers as the configuration using a means to connect said cathode electrode with the part in said touch-down potential too hastily in direct current as said inductance for impedance adjustment preferably.

[0047] Moreover, preferably, the outside of said cathode electrode is equipped with an electrode side dielectric, and it considers as the configuration in which this cathode electrode and this electrode side dielectric form the bottom wall of said reaction chamber.

[0048] Moreover, preferably, said cathode electrode has an anode electrode for the shape of a cylinder in nothing and its inside, and the outside of this cathode electrode is equipped with an electrode side dielectric, and it considers as the configuration whose this cathode electrode and this electrode side dielectric form the wall of said reaction chamber.

[0049] Moreover, it considers as the configuration of the electron device manufacturing installation [equipped with a capacity for impedance adjustment according to claim 1 to 7] according to claim 8 to 13 preferably.

[0050] Moreover, it is D>=(1/16) -lambda which fulfills the conditions of following the (4) type for the magnitude of said cathode electrode preferably. -- (4)

However, the maximum dimension lambda securable for D:cathode electrode surface:

Set it as the wavelength magnitude of the RF excited from a cathode electrode.

[0051] Moreover, it is D>=(1/8) -lambda which fulfills the conditions of following the (5) type for the magnitude of said cathode electrode preferably. -- (5)

However, the maximum dimension lambda securable for D:cathode electrode surface: Set it as the wavelength magnitude of the RF excited from a cathode electrode.

[0052] Moreover, it is D0<=(1/2) -lambda which fulfills the conditions of following the (6) type for the magnitude of said reaction chamber preferably. -- (6)

However, the electrode surface inside a D0:reaction chamber and the maximum dimension lambda securable in parallel: Set it as the wavelength magnitude of the RF excited from a cathode electrode.

[0053] Moreover, it is D0>=(1/2) -lambda which fulfills the conditions of following the (7) type for the magnitude of said reaction chamber preferably. -- (7)

However, the electrode surface inside a D0:reaction chamber and the maximum dimension lambda securable in parallel: Set it as the wavelength magnitude of the RF excited from a cathode electrode.

[0054] Moreover, an excitation frequency considers the RF conditions of said high-frequency power generating means as the configuration which sets it as the continuous discharge of a RF VHF band preferably.

[0055] Moreover, an excitation frequency considers the RF conditions of said high-frequency power generating means as the configuration which sets it as the pulse discharge of a RF VHF band preferably.

[0056] Moreover, the manufacture approach of the electron device of this invention uses an electron device manufacturing installation according to claim 1 to 20, and by plasma-exciting, decomposing material gas and depositing a thin film from a gaseous phase on a substrate, the above-mentioned purpose is attained by that, as it comes to manufacture an electron device.

[0057] Moreover, the above-mentioned purpose is attained by that as, as for the manufacture approach of the electron device of this invention, plasma particles and the active species by plasma excitation come to manufacture an electron device using etching the film using an electron device manufacturing installation according to claim 1 to 20.

[0058] Below, an operation of this invention is explained for the drawing of the below-mentioned operation gestalt, referring to suitably.

[0059] In this invention, the capacity for impedance adjustment with the capacity component below the stray capacity which the part which is in same electric potential in direct current with a cathode electrode and a cathode electrode between a cathode

electrode and the capacitative element for direct-current cutoff or between a cathode electrode and a high-frequency power generating means has as mentioned above to the part in the interior wall or touch-down potential of a reaction chamber is inserted so that it may become stray capacity and series connection.

[0060] As an example, as shown in drawing 1 , more specifically, the capacity 10 for impedance adjustment which consists of a capacitor is inserted between the capacitative elements 7 for direct-current cutoff which consist of cathode electrode 1a and a capacitor. Here, capacity of the capacity 10 for impedance adjustment is set to CC, and capacity of the capacitative element 7 for direct-current cutoff is set to CB. In addition, these cathode electrodes differ in the cathode electrode 1 shown in drawing 17 , connect electrically top cathode electrode 1a and bottom cathode electrode 1b, and are constituted, between both cathode electrode 1a and 1b, series connection of the capacitative element 10 for direct-current cutoff is carried out, and capacity CC is formed.

[0061] For this reason, magnitude C of the capacity of the whole cathode electrode is expressed with following the (12) type.

[0062]

C=1/{(1/CF) + (1-/CC)} -- (12)

therefore -- according to [if magnitude of CC is made below into CF, since C can be changed from the value of CF a lot] this invention -- a parallel resonating frequency f0 -- ******** from the frequency of an excitation RF -- things are made. That is, if it is made such a configuration, also when using the RF of a VHF band as an excitation RF, a parallel resonance condition can be avoided easily.

[0063] In addition, when the frequency f of a RF generally rises, all conductors begin to have a capacity component to a touch-down part. namely, a direct current -- it is possible that a capacity component arises and a stray capacity component changes also by the part which was able to be disregarded-like in the case of RF band RF. For this reason, when a frequency changes, the need of catching a parallel resonance phenomenon comes out in consideration of the newly produced stray capacity component. Taking this fact into consideration, it is necessary to insert the capacity CC for impedance adjustment so that a substantial stray capacity component may be decreased.

[0064] Moreover, even if it does not use the circuit element like a capacitor 10 itself as a capacity CC for impedance adjustment, control of the above-mentioned parallel resonating frequency is possible.

[0065] For example, as an example, as shown in drawing 3 , control of the above-mentioned parallel resonating frequency is possible also by insulating the

cathode electrode 1 from the high-frequency power generation source 4 in direct current using dielectric 11 grade. That is, it is because it is equivalent to inserting a capacity component as a RF, so a parallel resonance condition is easily avoidable with such a means as well as the case of drawing 1 .

[0066] According to this means, it is effective especially when the space which can insert a capacitor does not exist in the perimeter of a cathode electrode.

[0067] A parallel resonance phenomenon is produced when the magnitude LG LG of the induction component which exists equivalent between the anode electrodes 2 shown in the part in the touch-down potential which counters the cathode electrode 1 and its electrode surface fundamentally, for example, drawing 1 , drawing 3 , drawing 6 , etc., i.e., an inductance, changes, and since this inductance LG is expressed in periodic function to a frequency as mentioned above, it produces a parallel resonance phenomenon in the value of many frequencies.

[0068] However, if it takes into consideration that an equipment dimension (reaction space) is around 1m when actually considering membrane formation by plasma-CVD equipments, such as a solar battery for power, when using the RF of a VHF band, the parallel resonating frequency f0 of most a low degree will pose a problem. for example, the case where an equipment dimension is 1.6m angle (1.6mx1.6m) -- an inductance LG -- about 0.02-0.05 microhenries -- becoming -- CF -- several 100- the value of thousands of pF is taken and the parallel resonating frequency f0 of most a low degree is set to 40-100MHz.

[0069] In such a case, supposing he wants to enable excitation of the RF of all the fields from RF band to a VHF band, it is desirable that a parallel resonating frequency f0 can be set to a RF side from the frequency band of an excitation RF.

[0070] And as the magnitude of the whole capacity C when carrying out series connection of the capacity CC for impedance adjustment and the stray capacity CF shown in the above-mentioned (12) formula, it is necessary to set up, in order to satisfy this condition so that the conditions of following the (1) type may be fulfilled.

[0071]

C<=1/{LG (2 pi-f) and 2 } -- (1)

Moreover, it is possible to control a parallel resonating frequency f0 also by inserting in juxtaposition the inductance component LC which consists of a coil 12 to stray capacity CF. In this case, since the parallel connection section works equivalent as a capacity of magnitude CF-1/{(2 pi-f) 2 and LC}, it can raise a parallel resonating frequency f0. Here, it is necessary to have the magnitude more than CF-1/{(2 pi-f) 2 and LC=0, i.e., the value from which the magnitude of equivalent capacity serves as min, {(2 pi-f) 2 and CF}

as a value of the inductance component LC LC, i.e., the inductance for impedance adjustment. [1-/] That is, it is necessary to fulfill the conditions of the above-mentioned (2) formula.

[0072] Moreover, when the frequency f of a RF generally rises as mentioned above, all conductors begin to have a capacity component to a touch-down part. It is necessary to catch a parallel resonance phenomenon in consideration of the newly produced stray capacity component CF, and when a frequency f changes, it is necessary to set up the inductance LC for impedance adjustment so that the stray capacity component CF may be decreased substantially.

[0073] Moreover, as an inductance 12 for impedance adjustment (LC), although the coil is used, control of a parallel resonating frequency is possible in drawing 6 , also except a coil. For example, it can attain also by connecting the cathode electrode 1 with a touch-down part too hastily with a copper plate etc. in direct current. That is, it is because it is equivalent to inserting the inductance 12 for impedance adjustment as a RF also in this case.

[0074] According to this means, it is effective especially when the space which can insert a coil does not exist in the perimeter of the cathode electrode 1.

[0075] Moreover, it is possible by inserting in juxtaposition the inductance component LC which it is also one of the approaches of solving the above-mentioned technical problem to completely abolish such a parallel resonance phenomenon, and it becomes from a coil 12 to stray capacity CF also in that case. In this case, the parallel connection section works equivalent as an inductance of magnitude (2 pi-f) andLC/{1-(2 pi-f) 2 and LC-CF}. That is, the capacity component which had caused the parallel resonance phenomenon can be removed, and the cathode electrode 1 circumference can consider only as an inductance component equivalent. At this time, the value of an equivalent inductance needs to have the magnitude of a under the field used as forward, i.e., 1/, {(2 and pi-f) 2 and CF} as magnitude of the capacity component LC of the inductance for impedance adjustment. Namely, the capacity component LC of the inductance for impedance adjustment should just fulfill the conditions of following the (3) type.

[0076]

LC<1/{(2 and pi-f) 2 and CF} -- (3)

Moreover, as shown in drawing 19 , when the plasma-CVD equipment of a conventional type is used, that abnormality part discharge occurs is the case that the electrode dimension D is bigger than 1/16 of the wavelength lambda which is excitation RFs.

[0077] Then, it has set up so that magnitude D of a cathode electrode may be satisfied with this invention of the conditions of the above-mentioned (4) formula, and thereby,

control of abnormality part discharge is attained. For this reason, according to this configuration, the large area discharge and the large area film using the RF of a VHF band are realizable.

[0078] Moreover, that only abnormality part discharge arises without normal inter-electrode discharge taking place when the plasma-CVD equipment of a conventional type is used, as shown in drawing 19 is the case that the electrode dimension D is bigger than one eighth of the wavelength lambda which is excitation RFs.

[0079] Then, it has set up so that magnitude D of a cathode electrode may be satisfied with this invention of the conditions of the above-mentioned (5) formula, and thereby, control of abnormality part discharge is attained. For this reason, the large area discharge and the large area film using the RF of a VHF band are realizable with this configuration.

[0080] Moreover, if the value of the capacity component CC for impedance adjustment is decreased fulfilling the conditions of the above-mentioned (1) formula and it goes, a parallel resonating frequency f0 can be raised to the value shown by max and following (13) formula.

[0081] f0= c/lambda=c / 2D0 -- (13)

however, the wavelength c:velocity of light of the RF excited inside a D0:reaction chamber from the greatest dimension lambda:cathode electrode securable for an electrode surface and a parallel direction -- in this case, it is expressed with the above-mentioned (8) formula equivalent, and the capacity component CC takes stray capacity CF for becoming small, the capacity C in (12) types approaches 0, and the effect of stray capacity CF of it is lost.

[0082] Moreover, D0 is expressed with following the (14) type when the above-mentioned (13) formula is filled.

[0083]

D0=(1/2) -lambda -- (14)

Here, since (14) types are conditions one constant **** stands in a reaction chamber, it originates only in the structure between guided waves of inter-electrode space and a reaction chamber, and an impedance serves as an equivalent phenomenon physically with the maximum, i.e., parallel resonance, so that it may understand, if S2 in the above-mentioned (9) types is transposed to D0. That is, if D0 is set up so that the above-mentioned (6) formula may be filled, a parallel resonance phenomenon can be controlled on a desired frequency.

[0084] So, in this invention, the maximum dimension D0 securable for an electrode

surface and a parallel direction is considering as a configuration with which are satisfied of the conditions of the above-mentioned (6) formula inside the reaction chamber.

[0085] This is also the same as when using LC which fills the above-mentioned (2) formula as a component for impedance adjustment instead of the capacity component CC for impedance adjustment.

[0086] When D0 cannot be changed freely, it will become effective if LC which fills the above-mentioned (3) formula is used. That is, in this case, stray capacity CF will not exist substantially but LC will exist in LG and juxtaposition. That is, the value of LG is made to decrease, as shown in following the (15) type, and LC is L= 1/(1-/LG+1-/LC). -- (15)

D0 in the above-mentioned (13) types is made to decrease equivalent after all.

[0087] For this reason, following the (7) type D0>=(1/2) -lambda which becomes possible [avoiding a parallel resonance phenomenon and the maximum-ized phenomenon of an impedance regardless of the above-mentioned (6) formula used as a limit of the magnitude of D0, if LC which fills the above-mentioned (3) formula is used], and cannot cope with it when LC which fills CC or the above-mentioned (2) formula is used -- (7)

The inter-electrode discharge by ****** is attained.

[0088] So, in this invention, it considered as the configuration whose electrode surface and maximum dimension D0 securable in parallel are satisfied with the interior of a reaction chamber of the conditions of the above-mentioned (7) formula.

[0089] Moreover, although it is dependent on the magnitude of CC when the combination of LC which fills the capacity component CC and the above-mentioned (3) formula is adopted, it becomes possible to raise a parallel resonating frequency more than [of an in / (13) types] f0. For this reason, it becomes possible to avoid a parallel resonance phenomenon and the maximum-ized phenomenon of an impedance in the field of (7) types.

[0090]

[Embodiment of the Invention] The operation gestalt of this invention electron device manufacturing installation is concretely explained based on a drawing below.

[0091] (Operation gestalt 1) Drawing 1 shows the operation gestalt 1 of this invention electron device manufacturing installation. This electron device manufacturing installation is used as plasma-CVD equipment, and has arranged the anode electrode 2, top cathode electrode 1a, and bottom cathode electrode 1b from the bottom in the reaction chamber 6 which makes the shape of a cross-section rectangle. The drawing top right-hand side section of the bottom wall 60 of a reaction chamber 6 is grounded.

Moreover, the anode electrode 2 is electrically connected to the upper wall 61 of a reaction chamber 6, and the potential is a grand level.

[0092] Opening of the longitudinal-direction center section of the bottom wall 60 is carried out electrically, and the high-frequency power generation source 4 is arranged under this opening. Between the high-frequency power generation source 4 and bottom cathode electrode 1b, series connection of the capacitative element 7 for direct-current cutoff (CB) which consists of a capacitor is carried out. Moreover, opening of the gas port 5 is carried out to the part of the up approach of the side attachment wall 62 of a reaction chamber 6, and ingredient gas is introduced in a reaction chamber 6 through this gas port 5.

[0093] In addition, in this electron device manufacturing installation, series connection of the capacity 10 for impedance adjustment (CC) which consists of a capacitor between top cathode electrode 1a and bottom cathode electrode 1b is carried out. Moreover, the space between the anode electrode 2 and top cathode electrode 1a is the reaction space 3, and the substrate for thin film deposition is inserted here.

[0094] Here, the reaction space 3, i.e., an equipment dimension, is 1.6mx1.6m as an electrode surface and a parallel cross section. The dimension of cathode electrode 1a and the anode electrode 2 is 700mm angle. Moreover, the value of the stray capacity CF formed between the bottom walls 60 of bottom cathode electrode 1b and a reaction chamber 6 is 800pF.

[0095] Moreover, the mixed gas of a silane and hydrogen is used as ingredient gas. As a high-frequency power generation source 4, the RF generator and the matching circuit are attached and the serial variable capacitor (20-1000pF) in a matching circuit is used as a capacitor which constitutes the above-mentioned capacitative element 7 for direct-current cutoff (CB).

[0096] Next, as compared with equipment, it explains conventionally which shows the effectiveness of the plasma-CVD equipment of this operation gestalt 1 to drawing 17 . Drawing 20 shows frequency dependent [of magnitude |Z| of the impedance between the cathode electrode 1 in equipment - the anode electrode 2] conventionally which is shown in drawing 17 . As shown in this drawing, with equipment, the parallel resonance phenomenon is observed conventionally [this] in the place whose frequency f is about 45MHz. For this reason, when high-frequency power was actually introduced in equipment from the frequency adjustable high-frequency power generation source 4, the range of plasma production having happened normally between two electrodes 1 and 2 was 10-35MHz as a frequency. At this time, as for the equivalent impedance component LG of the reaction space 3, the above-mentioned (9) formula shows that it is

LG=0.025microhenry.

[0097] On the other hand, in the plasma-CVD equipment of this operation gestalt 1, when the capacity 10 (it is CC=100pF and this value satisfies the conditions of the above-mentioned (1) formula.) for impedance adjustment was inserted in the bottom of cathode electrode 1a, magnitude |Z| of an impedance changed [as seeming / it / that it is shown in drawing 2] like. At this time, it turns out that the parallel resonating frequency f0 is going up even to 72MHz.

[0098] In addition, if the value of the capacity CC of the capacity 10 for impedance adjustment is set up suitably, the 40-100MHz thing set up easily out of range will become possible about the parallel resonating frequency f0 of most a low degree.

[0099] Moreover, as shown in this drawing, there is almost no change of the impedance of RF band (nearly 10MHz). Therefore, it turns out that most effects of the capacity 10 (CC) insertion for impedance adjustment cannot be found to RF band RF. Thus, the plasma production between electrode 1a and 2 became possible on the frequency of 10-62MHz by actually controlling the impedance between electrode 1a and 2.

[0100] Thus, according to the plasma-CVD equipment of this operation gestalt 1, since a parallel resonating frequency f0 can be easily set to a RF side from the frequency band of an excitation RF, excitation of the RF of all the fields from RF band to a VHF band can be enabled.

[0101] For this reason, according to the plasma-CVD equipment of this operation gestalt 1, since the plasma production in the parallel monotonous mold large-sized manufacturing installation before and behind electrode dimension the angle of 1m becomes possible in the large frequency range ranging from RF band to a VHF band, RF-izing of the excitation RF electromagnetic field in fields, such as a solar battery for power and a liquid crystal display component, and large area-ization of a membrane formation substrate can be attained.

[0102] In addition, although this invention is applied to plasma-CVD equipment equipped with the capacitative element 7 for direct-current cutoff (CB) with the above-mentioned operation gestalt 1, this invention is applicable similarly about the plasma-CVD equipment which is not equipped with such a capacitative element 7 for direct-current cutoff (CB). In this case, what is necessary is just to insert the capacity 10 for impedance adjustment (CC) between cathode electrode 1a and the high-frequency power generation source 4.

[0103] Moreover, although the above-mentioned explanation explained the case where this invention electron device manufacturing installation was applied to plasma-CVD equipment, it can apply also about the plasma dry etching (Usher) equipment into

which plasma particles and the active species by plasma excitation etch the film, and the same effectiveness as the above can be done so.

[0104] (Operation gestalt 2) Drawing 3 and drawing 4 show the operation gestalt 2 of this invention electron device manufacturing installation. The electron device manufacturing installation of this operation gestalt 2 is also applied to plasma-CVD equipment, and only the means used as the capacity CC for impedance adjustment differ in the above-mentioned operation gestalt 1. That is, with this operation gestalt 2, although a capacitor is inserted and the capacity CC for impedance adjustment is formed with the operation gestalt 1, as shown in drawing 3 , between up-and-down cathode electrode 1a and 1b, the dielectric 11 of 50mm in thickness and specific inductive capacity 3.0 is inserted, and the capacity 11 for impedance adjustment (CC) is formed. In addition, the sign same about the part which is common to the equipment of the operation gestalt 1 is attached, and it omits about concrete explanation.

[0105] Drawing 4 shows frequency dependent [of magnitude |Z| of the impedance between cathode electrode 1a in the plasma-CVD equipment of this operation gestalt 2 - the anode electrode 2]. The parallel resonating frequency f0 was going up even to 66MHz, and the plasma production between electrode 1a and 2 was possible for it on the frequency of 10-55MHz so that drawing 4 might show.

[0106] Therefore, also in the plasma-CVD equipment of this operation gestalt 2, the same effectiveness as the above-mentioned operation gestalt 1 can be done so. In addition, according to this operation gestalt 2, there is an advantage applicable also about equipment without the space which inserts a capacitor in the perimeter of cathode electrode 1a.

[0107] (Operation gestalt 3) Drawing 5 shows the operation gestalt 3 of this invention electron device manufacturing installation. The electron device manufacturing installation of this operation gestalt 3 is also applied to plasma-CVD equipment, and only the following points differ in the above-mentioned operation gestalten 1 and 2. That is, as shown in drawing 5 , with this operation gestalt 3, the dielectric 11 was installed on the cathode electrode 1, this formed the capacity 11 for impedance adjustment (CC), and the configuration which removed the electrode corresponding to top cathode electrode 1a of the operation gestalt 2 is adopted. In addition, the same sign is given to the operation gestalten 1 and 2 and a corresponding part.

[0108] here -- a dielectric 11 -- from 35mm in thickness, and quality-of-the-material Teflon (specific inductive capacity 2.0) -- becoming -- the object for impedance adjustment -- it is capacity CC=250pF.

[0109] According to the above-mentioned configuration, the electron in the plasma

generated by the reaction space 3 is incorporated on the front face of a dielectric 11, and it is electrified by the front face of a dielectric 11. For this reason, the front face facing the reaction space 3 of a dielectric 11 carries out the same work as top cathode electrode 1a of the operation gestalt 2.

[0110] Moreover, since film deposition takes place also to the front face of a dielectric 11 and the film has a certain amount of conductivity when making an a-Si:H thin film etc. deposit using a silane etc. as ingredient gas, the film also carries out the same work as top cathode electrode 1a of the operation gestalt 2.

[0111] Moreover, as the quality of the material of the dielectric 11 which constitutes the capacity CC for impedance adjustment, it is also possible to use quartz glass (70mm in specific inductive capacity 4.0, thickness) or a ceramic (175mm in an alumina, specific inductive capacity 10.0, thickness). Even in this case, it has checked that the almost same effectiveness was acquired.

[0112] Frequency dependent [of magnitude |z| of the impedance between the cathode electrode 1 in the plasma-CVD equipment of this operation gestalt 3 - the anode electrode 2] showed the almost same property as drawing 4 of the operation gestalt 2. This is because the almost same thing as the operation gestalt 2 was used as a capacity of a dielectric (capacity CC for impedance adjustment) 11.

[0113] However, when thickness distribution of the thin film deposited on the glass substrate installed in the front face of the anode electrode 2 was investigated, what is depended on this operation gestalt 3 remained to **8% to it having been **4% which is depended on the operation gestalt 2. It is because this has the low conductivity of the surface section of a dielectric 11.

[0114] For this reason, although the plasma-CVD equipment of the operation gestalt 3 has the advantage that equipment structure becomes easy compared with the plasma-CVD equipment of the operation gestalt 2, since it has the fault that the thickness distribution within the field of a membrane formation thin film exists, when arranging many especially small area substrates on the front face of the anode electrode 2 and forming membranes, it will become effective.

[0115] (Operation gestalt 4) Drawing 6 and drawing 7 show the operation gestalt 4 of this invention electron device manufacturing installation. The electron device manufacturing installation of this operation gestalt 4 is also applied to plasma-CVD equipment, and only the following points differ in the above-mentioned operation gestalten 1-3. That is, as shown in drawing 6 , with this operation gestalt 3, the configuration which inserted in the stray capacity CF of the cathode electrode 1 and juxtaposition the inductance 12 for impedance adjustment (LC) which becomes the

inferior surface of tongue of the cathode electrode 1 from a coil is taken.

[0116] The value of the inductance LC for impedance adjustment at this time is set as LC=0.007microhenry, and this value satisfies the conditions of the above-mentioned (2) formula. In addition, the sign same about the part which is common to the equipment of the operation gestalten 1 and 2 is attached, and it omits about concrete explanation.

[0117] Drawing 7 shows frequency dependent [of magnitude |Z| of the impedance between the cathode electrode 1 in the plasma-CVD equipment of this operation gestalt 4 - the anode electrode 2]. The parallel resonating frequency f0 was going up even to 72MHz, and the plasma production between an electrode 1 and 2 was possible for it on the frequency of 10-66MHz so that drawing 7 might show.

[0118] Therefore, also in the plasma-CVD equipment of this operation gestalt 4, the same effectiveness as the above-mentioned operation gestalt 1 can be done so.

[0119] In addition, although the inductance 12 for impedance adjustment (LC) is formed with the coil with this operation gestalt 4, control of a parallel resonating frequency is possible also except a coil. For example, it can attain also by connecting the cathode electrode 1 with a touch-down part too hastily with a copper plate etc. in direct current. That is, it is because it is equivalent to inserting the inductance 12 for impedance adjustment (LC) as a RF also in this case.

[0120] According to this operation gestalt, it is effective especially when the space which can insert a coil does not exist in the perimeter of the cathode electrode 1.

[0121] (Operation gestalt 5) Drawing 8 and drawing 9 show the operation gestalt 5 of this invention electron device manufacturing installation. The electron device manufacturing installation of this operation gestalt 5 is also applied to plasma-CVD equipment, and only the following points differ in the above-mentioned operation gestalten 1-4. That is, as shown in drawing 8 , with this operation gestalt 5, the structure which inserted in the stray capacity CF of cathode electrode 1b and juxtaposition the inductance 12 for impedance adjustment which inserts a dielectric 11, and forms the capacity 11 for impedance adjustment (CC) among the cathode electrodes 1a and 1b, and becomes the inferior surface of tongue of cathode electrode 1b from a coil 12 is taken. That is, it is what combined the structure of the operation gestalt 2 and the operation gestalt 4. In addition, the same sign is given to these operation gestalten and a corresponding part.

[0122] In the above-mentioned configuration, a dielectric 11 consists of 2mm in thickness, and quality-of-the-material Teflon (specific inductive capacity 2.0), and the coil 12 is formed by two or more coil mold copper plates.

[0123] Here, the capacity CC for impedance adjustment and the inductance LC for

impedance adjustment are CC=4200pF and LC=0.003microhenry, respectively, and the value of LC satisfies the above-mentioned (2) formula or (3) types according to an operating frequency.

[0124] Moreover, as the quality of the material of the dielectric 11 which constitutes the capacity CC for impedance adjustment, it is also possible to use quartz glass (4mm in specific inductive capacity 4.0, thickness) or a ceramic (10mm in an alumina, specific inductive capacity 10.0, thickness), and it has checked that the almost same effectiveness was acquired also in this case.

[0125] Drawing 9 shows frequency dependent [of magnitude |z| of the impedance between the cathode electrode 1 in the plasma-CVD equipment of this operation gestalt 5 - the anode electrode 2]. The parallel resonating frequency f0 is going up to 100MHz or more, and the plasma production between the cathode electrode 1 and an anode 2 is possible for it on the frequency of 10-94MHz so that drawing 9 may show. That is, with the plasma-CVD equipment of the same magnitude of a conventional type, it has checked that inter-electrode discharge was realizable in the field (frequency > 54MHz) of the above-mentioned (5) formula which was not able to obtain normal inter-electrode discharge. The reason is as by the way the above-mentioned operation having stated.

[0126] Using the plasma-CVD equipment of this operation gestalt 5, the frequency was fixed to 81.36MHz, the glass substrate of 50cmx50cm magnitude was installed in the front face of the anode electrode 2 by 1mm thickness, and the a-Si:H thin film was made to actually deposit. The reactant gas used at this time was a silane and hydrogen, it introduced from the gas port 5 by the flow rate of 300sccm(s) and 500sccm, respectively, and the pressure of the reaction space 3 was set to 0.3Torr(s).

[0127] According to this operation gestalt 5, since the plasma production between the cathode electrode 1 and the anode electrode 2 became possible, the effectiveness of a rise of the membrane formation rate by the rise of the frequency observed with small equipment so far was able to be efficiently employed also in large-sized equipment. The obtained thin film parameter is shown in the following table 1.

[0128]

[Table 1]

[0129] Here, as quality of an a-Si:H thin film solar cell, the one with few amounts of Si-H2 association in the film where the defect density in the film is lower can call it high quality.

[0130] As RF conditions for the high-frequency power generation source 4, as an example, as shown in Table 1, with the plasma-CVD equipment of this operation gestalt 5, continuous discharge with a frequency of 81MHz and a pulse discharge with a frequency of 81MHz were set up. In addition, with equipment, it is continuous discharge with a frequency of 13.56MHz conventionally which is shown [be / it / under / Table 1 / contrast].

[0131] Now, when based on the continuous discharge of high-frequency power 300W, with this operation gestalt 5, membrane formation rate =90 nm/min and the defect density in the film are set to 5x1014cm-3, and, in the membrane formation rate, about 15 times and the defect density in the film are decreasing a figure single [about] conventionally as compared with the case of equipment.

[0132] Moreover, when based on the pulse discharge of 50micro of 5micro sec off time amount sec of time average power 300 W and pulse-on time amount of a RF, in 65 nm/min and the defect density in the film, 4x1014cm-3 and the amount of Si-H2 association in the film become [a membrane formation rate] 1%, and, in the membrane formation rate, about 11 times and the amount of Si-H2 association in the film are decreasing by about 1 / 3 times conventionally as compared with the case of equipment. Therefore, if the plasma-CVD equipment of this operation gestalt 5 is used, a quality thin film is producible to up to a large area substrate with a quick membrane formation rate.

[0133] In addition, although the electron device manufacturing installation of this operation gestalt 5 is applied to plasma-CVD equipment in the above-mentioned explanation, it is also possible by introducing the etching gas of CCl4 grade as reactant gas to constitute the plasma dry etching (Usher) equipment using VHF discharge of large area correspondence with the same equipment.

(Operation gestalt 6) Drawing 10 and drawing 11 show the operation gestalt 6 of this invention electron device manufacturing installation. The electron device manufacturing installation of this operation gestalt 6 is also applied to plasma-CVD equipment, and only the following points differ in the above-mentioned operation gestalten 1-5. With each above-mentioned operation gestalt, although it was the structure, i.e., internal mold equipment, where the cathode electrode 1 whole was contained in a reaction chamber 6, this operation gestalt 6 has become the structure, i.e.,

EKUSUTANARU mold equipment, where the cathode electrode 1 and the electrode side dielectric 13 constitute the bottom wall of a reaction chamber 6, as shown in drawing 10 . In addition, the same sign is given to each above-mentioned operation gestalt and a corresponding part.

[0134] In the case of this EKUSUTANARU mold structure, since reactant gas does not flow, the space 14 under the cathode electrode 1 does not need to take an airtight structure. For this reason, according to this structure, since disconnection is easy, the inductance 12 for impedance adjustment which consists of a coil 12 can be easily attached in the inferior surface of tongue of the cathode electrode 1. Moreover, there is an advantage which can also perform easily tuning for being referred to as LC according to a frequency using each time.

[0135] As an example, a coil 12 is formed in below with two or more coil mold copper plates, and the inductance LC for impedance adjustment shows the case where it is set to LC=0.007microhenry to it. The dotted line in drawing 11 shows frequency dependent [of magnitude |z| of the impedance between the cathode electrode 1 in the plasma-CVD equipment when not attaching the inductance 12 for impedance adjustment - the anode electrode 2]. Moreover, the continuous line in drawing 11 shows frequency dependent [at the time of attaching this operation gestalt 6 12, i.e., the inductance for impedance adjustment, / of |z|].

[0136] As drawing 11 shows, from the first, what was 52MHz is going up even to 80MHz by attaching the inductance 12 for impedance adjustment, and a parallel resonating frequency f0 understands that the plasma production between an electrode 1 and 2 is possible on the frequency of 10-76MHz.

[0137] (Operation gestalt 7) Drawing 12 and drawing 13 show the operation gestalt 7 of this invention electron device manufacturing installation. The electron device manufacturing installation of this operation gestalt 7 is also applied to plasma-CVD equipment, and the following points differ in the above-mentioned operation gestalten 1-6. That is, although the plasma-CVD equipment of the operation gestalten 1-6 has taken the electrode structure of an parallel monotonous mold, the plasma-CVD equipment of this operation gestalt 7 has the cylindrical electrode structure where an outside and the anode electrode 2 serve as [the cathode electrode 1] the inside, as shown in drawing 12 . In addition, the same sign is given to the above-mentioned operation gestalt and the corresponding part.

[0138] Like [this type of equipment] the operation gestalten 1-6, it is a capacitive coupled plasma CVD system, and when exciting a VHF RF here, the problem from which discharge becomes unstable similarly occurs. Since the cathode electrode 1 and

the electrode side dielectric 13 are EKUSUTANARU mold equipment which makes the wall of a reaction chamber serve a double purpose in the case of this equipment, there is an advantage which can perform easily installation and tuning of the inductance LC for impedance adjustment (coil 12) like the operation gestalt 6.

[0139] Here, a coil 12 is formed by two or more coil mold copper plates, and the inductance LC for impedance adjustment is LC=0.007microhenry. As a dimension, the radius of 20cm and the anode electrode 2 serves as [the bore of the cathode electrode 1] height of 80cm by 10cm.

[0140] The dotted line in drawing 13 does not attach the inductance 12 for impedance adjustment, that is, shows frequency dependent [of magnitude |z| of the impedance between the cathode electrode 1 in the plasma-CVD equipment in the case of equipment - the anode electrode 2] conventionally. Moreover, the continuous line in drawing 13 shows frequency dependent [at the time of attaching this operation gestalt 7 12, i.e., the inductance for impedance adjustment, / of |z|].

[0141] From the first, when what was 32MHz attaches the inductance 12 for impedance adjustment, the parallel resonating frequency f0 is going up even to 86MHz, and the plasma production between the cathode electrode 1 and the anode electrode 2 of it becomes possible on the frequency of 10-78MHz, so that drawing 13 may show.

[0142] (Operation gestalt 8) Drawing 14 shows the operation gestalt 8 of this invention electron device manufacturing installation. Excitation of the RF of all the fields from RF band to a VHF band of this operation gestalt 8 is enabled by changing the value of the impedance adjustment capacity CC like the above-mentioned operation gestalt 1. Other conditions are the same as the operation gestalt 1. In addition, the equipment dimension D0 is 1.6m.

[0143] A parallel resonating frequency f0 can be controlled by magnitude to the above-mentioned (13) formula by making magnitude of the impedance adjustment capacity CC small, and going so that drawing 14 may show.

[0144] On the contrary, the control limitation of a parallel resonating frequency f0 can be changed by changing the equipment dimension (magnitude of a reaction chamber = the electrode surface inside a reaction chamber, and the maximum dimension securable in parallel) D0. For example, when the equipment dimension D0 was made small in the same equipment dimension of 700mm as the dimension of an electrode, it is possible to make a parallel resonating frequency f0 large even to 210MHz, and inter-electrode discharge was attained even by 200MHz in this case.

[0145] (Operation gestalt 9) Drawing 15 shows the operation gestalt 9 of this invention electron device manufacturing installation. This operation gestalt 9 enables excitation

of the RF of all the fields from RF band to a VHF band of the value of the inductance LC for impedance adjustment by making it change, filling the above-mentioned (2) formula like the above-mentioned operation gestalt 4. Other conditions are the same as the operation gestalt 4, and the equipment dimension D0 is 1.6m.

[0146] The parallel resonating frequency f0 is controllable in the magnitude to (12) types by making small magnitude of the inductance LC for impedance adjustment, and going so that drawing 15 may show.

[0147] On the contrary, the control limitation of a parallel resonating frequency f0 can be changed by changing the equipment dimension D0. For example, the same thing as the dimension of an electrode a parallel resonating frequency f0 will be made [the thing] large even to 210MHz for the equipment dimension D0 if it is made small to 700mm is possible, and inter-electrode discharge was attained even by 200MHz in this case.

[0148] (Operation gestalt 10) Drawing 16 shows the operation gestalt 10 of this invention electron device manufacturing installation. With this operation gestalt 10, excitation of the RF of all the fields from RF band to a VHF band of the value of the inductance LC for impedance adjustment is enabled by making it change, filling the above-mentioned (3) formula like the operation gestalt 4.

[0149] The parallel resonating frequency f0 is controllable by enlarging the inductance LC for impedance adjustment and going exceeding a limit of (13) types so that drawing 16 may show.

[0150] Theoretically, it is possible to raise a parallel resonating frequency f0 or the maximum-ized phenomenon of an impedance to infinity. In this operation gestalt 10, inter-electrode discharge on the frequency of 135.6MHz was actually possible. This technique can apply the equipment dimension D0 also to the case where it cannot change, and the equipment, with which the existing equipment dimension D0 was decided conversely, and is an effective means in various equipments.

[0151] (The manufacture approach of this invention electron device) If the plasma-CVD equipment shown in the above-mentioned operation gestalten 1-10 is used, the electron device of the outstanding quality as shown in Table 1 can be manufactured. That is, it plasma-excites and material gas is decomposed, and if a thin film is deposited from a gaseous phase on the substrate introduced in the reaction chamber, the electron device which has such growth film is producible.

[0152] Moreover, if etching processing of the film is carried out using plasma particles and the active species by plasma excitation etching the film by the electron device manufacturing installation shown in the operation gestalten 1-10, the electron device

which has the film of the outstanding large area of quality is efficiently producible.

[0153]

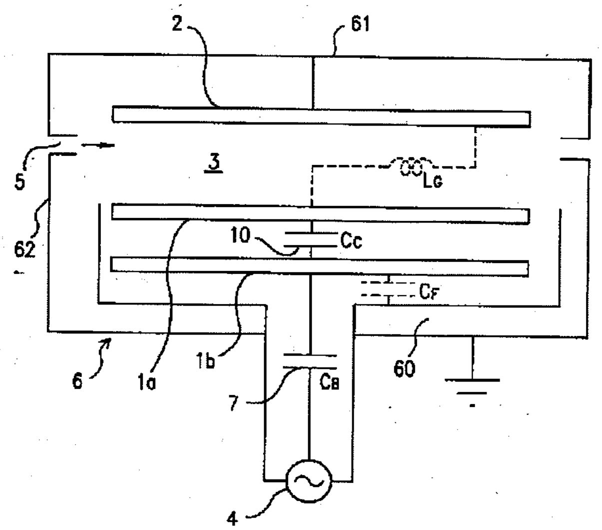
[Effect of the Invention] the case where the above this invention electron device manufacturing installation is applied to an RF plasma CVD system -- a parallel resonating frequency -- ******** from the frequency of an excitation RF -- since things are made, the plasma production in the parallel monotonous mold large-sized manufacturing installation before and behind electrode dimension the angle of 1m becomes possible in the large frequency range ranging from RF band to a VHF band. Therefore, the place which enables RF-izing of the excitation RF electromagnetic field in the field of giant microelectronics, such as a solar battery for power and a liquid crystal display component, and large area-ization of a membrane formation substrate, and contributes to the upgrading industrially is large. Moreover, the manufacture effectiveness can be improved by leaps and bounds.

[0154] Especially, in the RF plasma CVD system of a conventional type, in the large area electrode and VHF band frequency domain which was not able to respond, with the simple means of dielectric installation and coil installation, when realizing normal discharge, very big effectiveness shows up. And the effectiveness is demonstrated in various electrode configurations, such as an internal mold, an EKUSUTANARU mold, and a drum type, the giant microelectronics field is begun, and it is useful also in the photo conductor device field for electrophotography.

[0155] Since application of the VHF band RF to large-sized equipment is attained in fields, such as a liquid crystal display component, also when similarly plasma particles and the active species by plasma excitation apply to the plasma dry etching system which etches the film, the upgrading can be planned industrially and manufacture effectiveness can be improved.

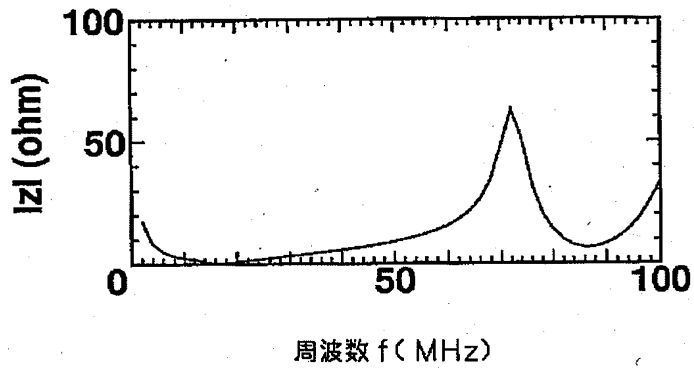
[0156] Moreover, according to the electron device manufacture approach of this invention, there is an advantage which can produce efficiently the electron device which has the above properties.

【図１】



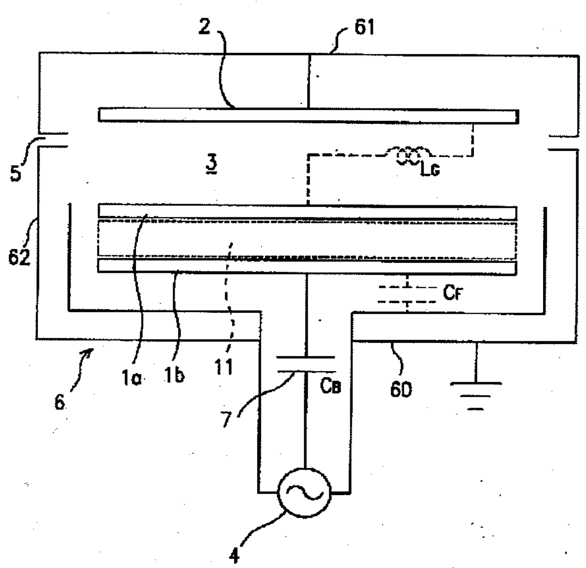
2
61
3
5
LG
62
10
Cc
CF
6
1a
1b
7
CB
60
4

【図２】



100
50
0
|Z| (ohm)
50
100
周波数 f (MHz)

【図３】



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LG
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1a
1b
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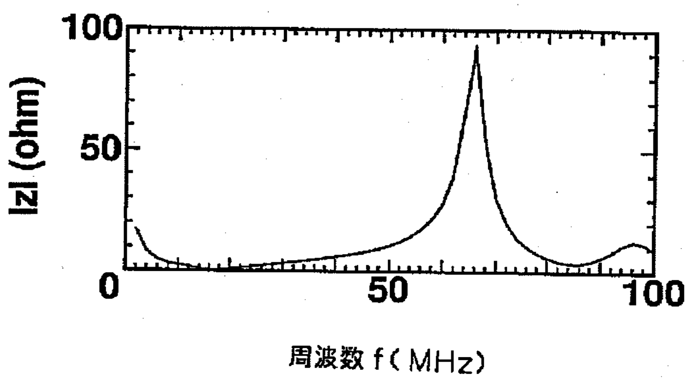
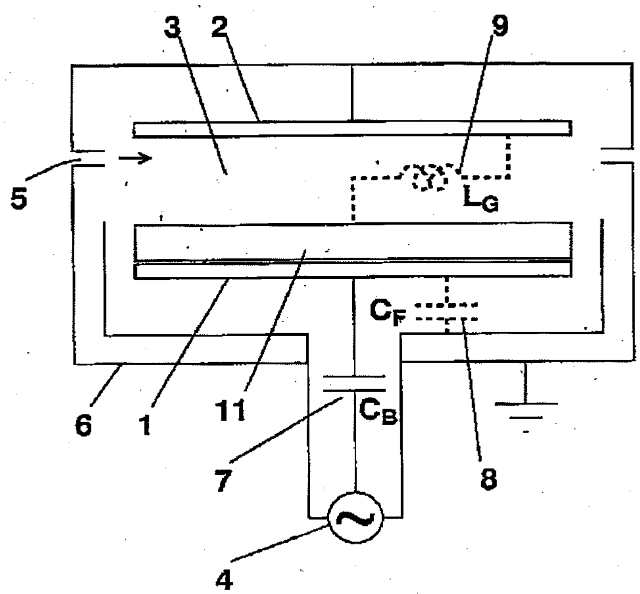
4

【図４】



100
50
0
|Z| (ohm)
50
100
周波数 f (MHz)

【図５】



3
2
9
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LG
CF
6
1
11
CB
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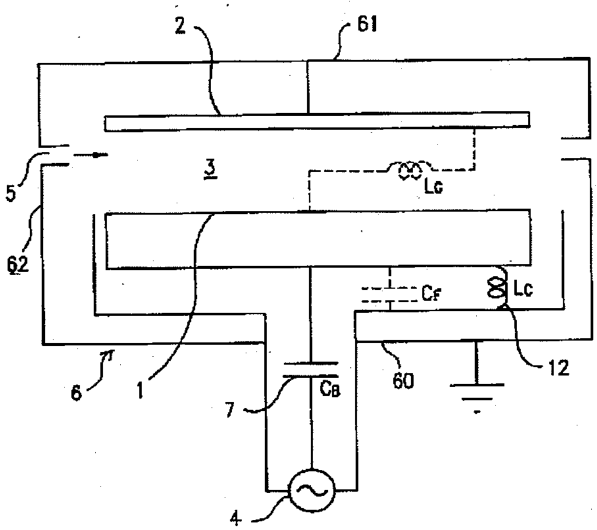
8
4

【図６】



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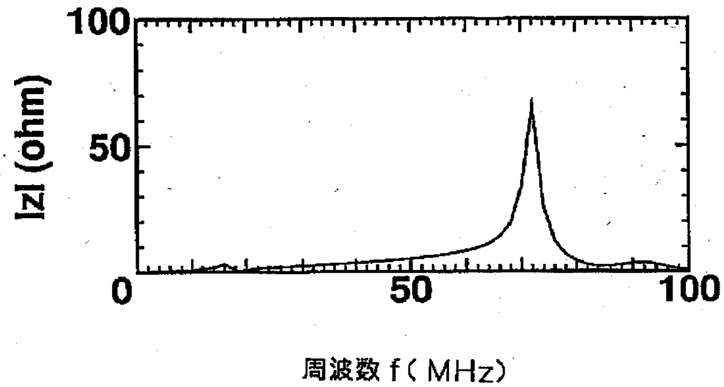

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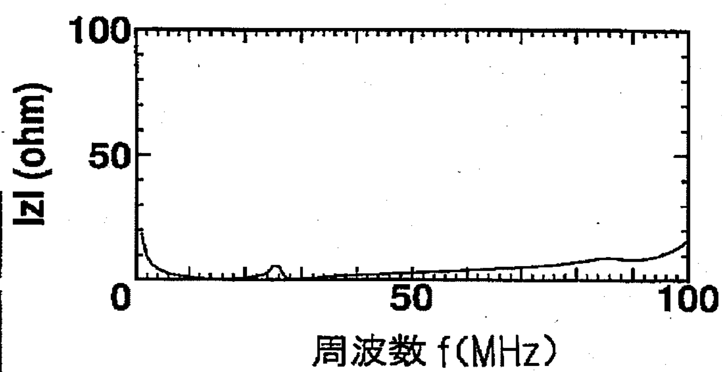

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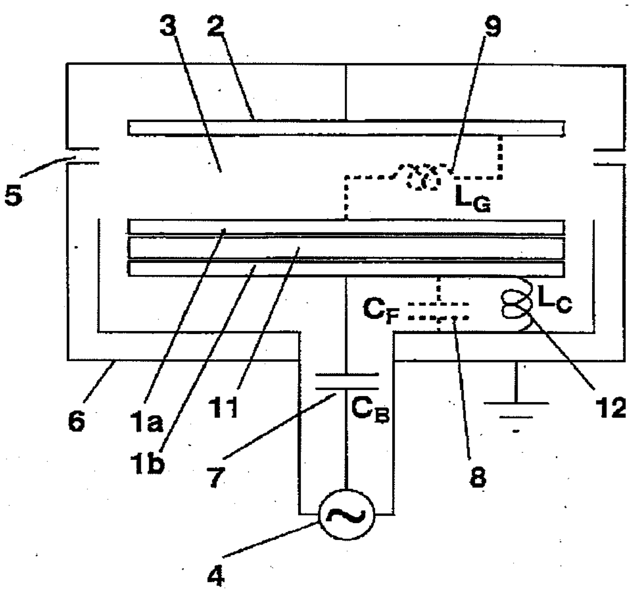

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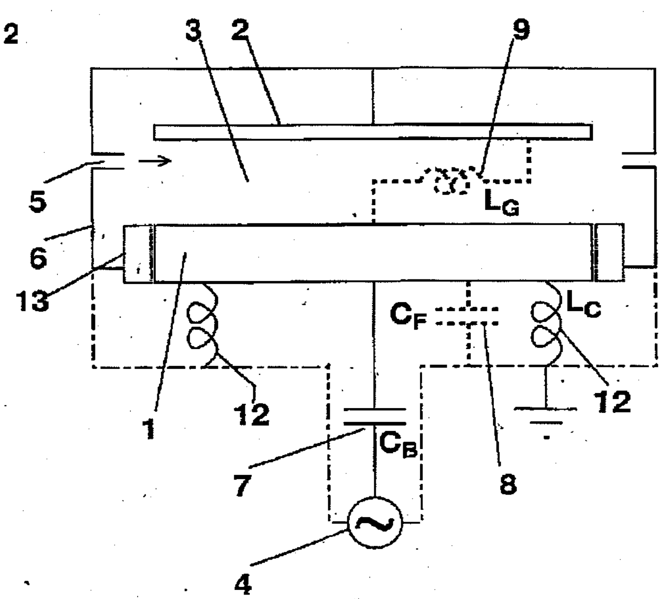

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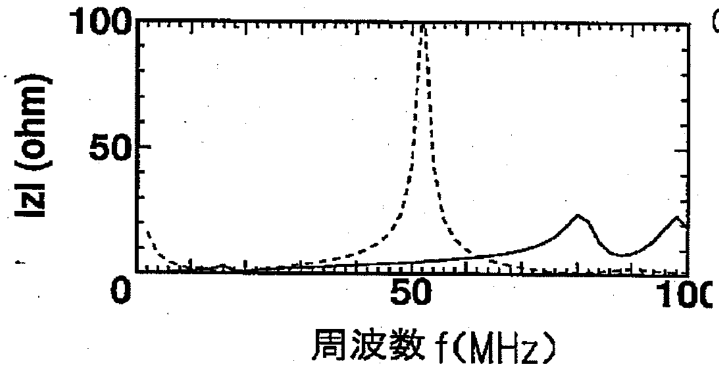

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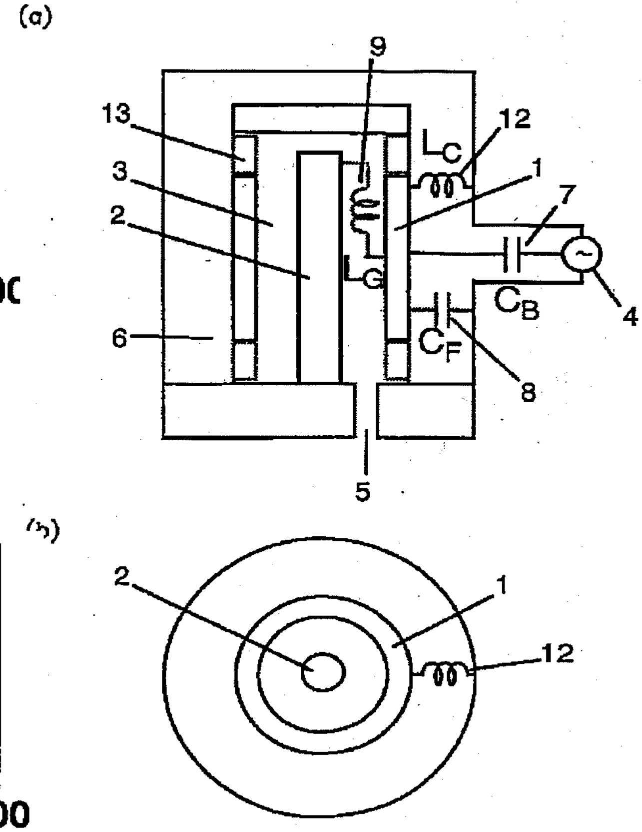

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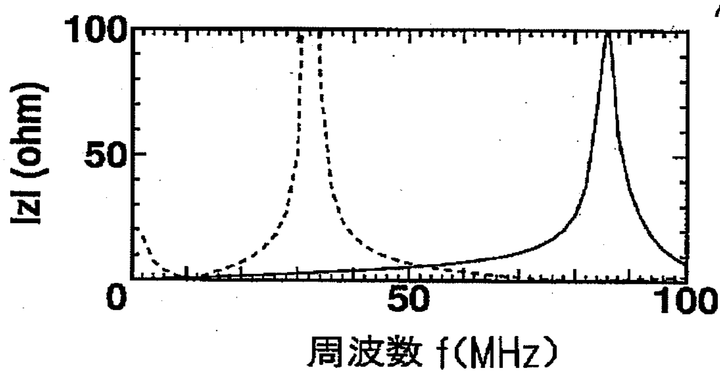

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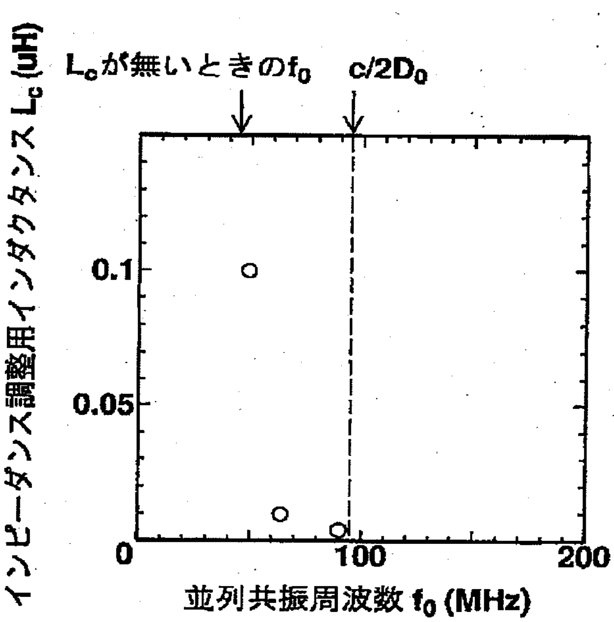

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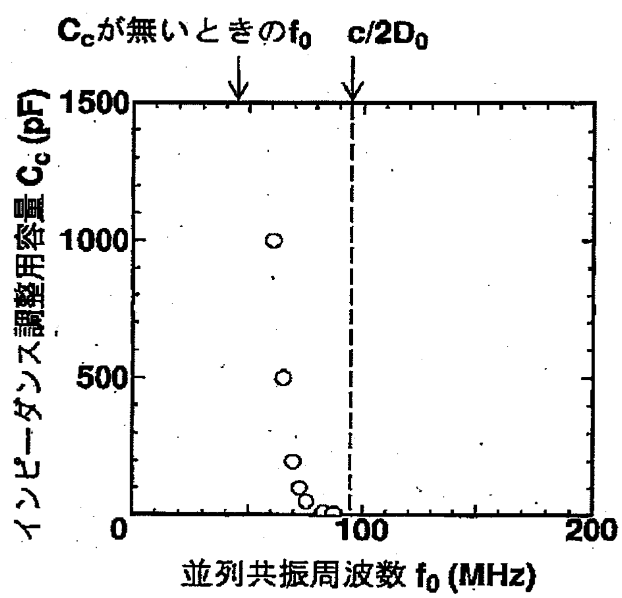

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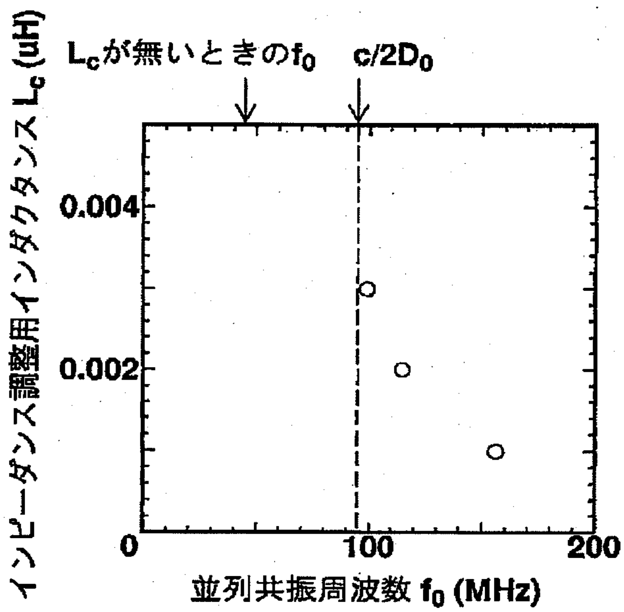

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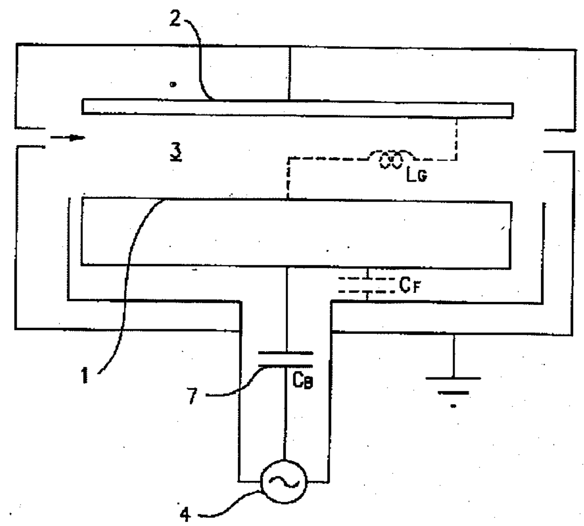

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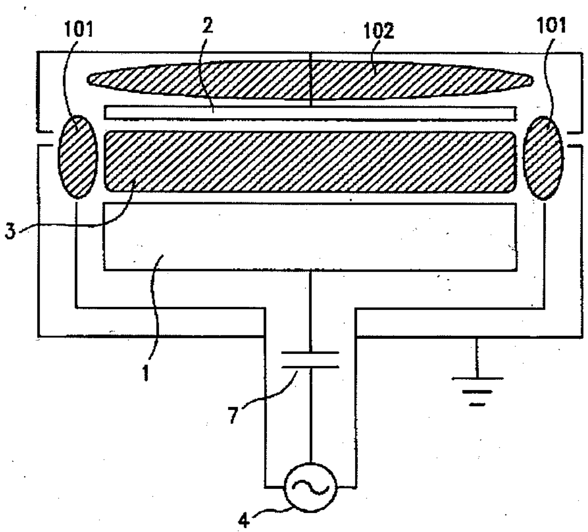

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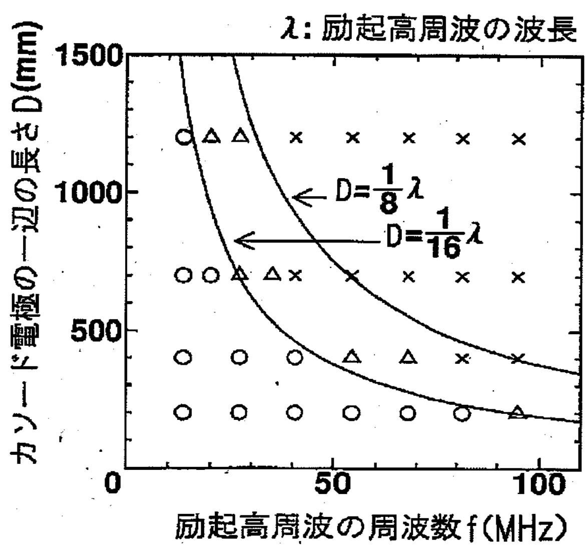

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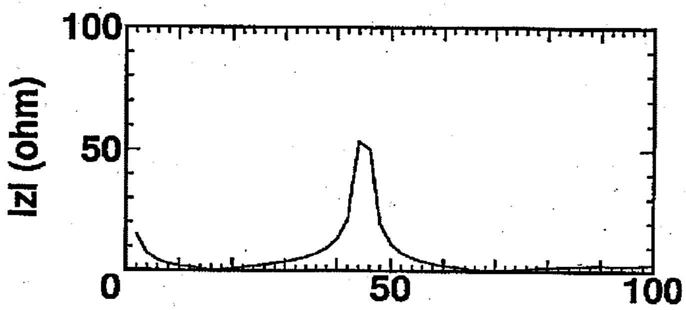

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